

THE ECLIPSE.

The Total Obscuration of the Sun.

Jan. 1.

BY A. G. WINTERHALTER, LIEUTENANT, U. S. NAVY, U. S. NAVAL OBSERVATORY, WASHINGTON, D. C.

CLIPSES, lunar and solar, have by the un-civilized been from time immemorial viewed with fear and trembling, and a long step forward in civilization is shown by the change of feeling marked by the announcement of their prediction; in this, as in other events, the unexpected being universally far-inspiring. In the eclipse the astronomer, journeying perhaps thousands of miles to a island in the great South Sea, still will see the evidence of terror excited in the natives by the un-wonted appearances. There is probably no more forcible illustration of the axiom that knowledge is power than the attitudes of savage and scientist towards the phenomena of the total solar eclipse. The former, not aware of the coming of the eclipse, is transfixed by fear as it approaches; the latter, enabled to predict the time of its advent, anxiously awaits the revelations it may afford.

The stories told of the influence which the early discovery of the eclipses was able to exercise over the Indians by predicting the time when the Great Father would visit his face, are familiar. Eclipses have been predicted from an early time. Thales, one of the seven sages, born about 640 years before the Christian era, is said to have taught the true nature of the lunar eclipse. Being the most striking of celestial phenomena visible to the naked eye, the desire to account for the cause of eclipses may be supposed to have arisen at a very early day. Long before the motions of the heavenly bodies were well understood, material was historically accumulating for the prediction of the occurrence of eclipses. Less than a score of years suffices to establish a recurrence of exactly the same positions of sun and moon with reference to the earth. The period, or cycle, of 18 years and 11 days includes all the kinds of solar eclipses liable to occur, so that it may be said that each eclipse is the type of one to occur 18 years later. This relation once established, it is easy to see how the ancient astronomers could predict eclipses with an accuracy knowledge of the motions of the moon or of the earth. Of course such predictions have become more and more accurate as knowledge of these motions became better known.

CAUSE OF ECLIPSES. In the case of the sun being eclipsed, the relative position of the three bodies—earth, moon and sun—are readily seen from the sketch. The shadow of the moon striking the earth causes the sun to appear darkened or eclipsed. In the case of a lunar eclipse, however, the relative position of the three bodies—earth, moon and sun—are readily seen from the sketch. The shadow of the earth striking the moon causes the moon to appear darkened or eclipsed.

ever, the relative position of the bodies is changed. The earth then occupies the intermediate place between the sun and the moon, and its shadow falling on the moon obscures that body. When the moon, earth and sun are in the positions shown in the figure, we have a new moon, as solar eclipses can occur only when the moon is in the position assigned above to the three bodies for a lunar eclipse, the moon is full, and lunar eclipses are found only at the time of full moon.

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go to roost, cocks crow, while a weird darkness best appreciated by the feelings hovers over everything. Though the general terms in which solar eclipses are described are the same for different occasions, the rapidly-shifting scenes, changing even in the short duration of the eclipse, give the phenomena unexpected characteristics, and each totality shows appearances of grandeur and sublimity different from those of its predecessor. Drawings of the corona made by observers at the same place are seldom alike in details, and may vary much in important attributes. But none may have recourse to the impartiality of photography. The sensitive dry-plate receives an impression in a short time, and forever fixes the peculiarities of the picture. Personal bias is removed.

THE ECLIPSES OF 1889. The year 1889 furnishes three solar eclipses—Jan. 1, June 27 and Dec. 21—the first and last total, the second annular; also, two lunar eclipses, Jan. 16 and July 12. The second total



PATHWAY OF THE ECLIPSE.

solar eclipse will be visible in the Island of Trinidad, in French Guiana and on the west coast of Africa, in about latitude 10 degrees south. The duration of totality at those places will vary from nearly two to a little over three minutes.

The total solar eclipse of Jan. 1, 1889, the last one visible in the United States in this century, begins at sea in the Pacific Ocean, embraces the greater part of North America, and ends in the southeastern part of Texas. The most interesting part of the eclipse, the totality, is, however, visible to only a comparatively small part of North America. The central eclipse begins in 179 degrees east longitude, 53 degrees north latitude, a point north of some of the western Alaskan Islands. The zone of totality then passes to the southeast, crossing some of the small islands of the Andromed group. After crossing the meridian of 140 degrees west longitude, it gradually sweeps to the northeast, the center striking the mainland at Point Arena, Cal. Its course through northern California can then be traced on the map provided for that purpose. If of interest, the belt can be easily prolonged through Nevada northeast, curving slightly northwards. The central eclipse comes to an end in 94 degrees west longitude, 52 degrees north latitude, or about at the center of Manitoba, to the west of the center of the Pacific Coast, which, combined with the low altitude at which the sun will be seen on account of its great southern declination, does not present very favorable circumstances for observation.

At Point Arena, Cal., the total phase begins at 1:30 p. m., and lasts exactly two minutes; the sun will be 25 degrees high. In California, places near the center line are Willow and Nelson in the C. & O. R. R. Quincy, Nevada City and Susanville. At San Francisco the eclipse will not be total, although nearly so.

East of the boundary between California and Nevada, the belt of totality, stretching to the northeast, leaves Reno just outside to the south and Fort McDermitt to the north, embracing, however, Winnemucca, six miles, and Tuscarora, 30 from the central line, both south of it. Of these, Winnemucca will be easiest of access, lying on the C. P. R. R.

Unfortunately, the weather at this time of the year is not favorable for observation. Near the coast: fogs and clouds, if not rain, prevail. But beyond the range of mountains to the eastward, stations little less favorable, as regards the time and the altitude, will be found.

ANNUAL ECLIPSES. Lunar eclipses show interesting phenomena, which yield, however, in importance and beauty to those presented by solar eclipses. The intervention of the moon, obscuring for the time being the face of the sun, reveals to us its surroundings, ordinarily hidden by the intense glare. We can, then, during total eclipses study the neighborhood of the sun, and although it is for only a brief space of time, investigate, by the delicate instruments at our disposal, the constitution of its appendages.

Astronomers of old indicated the size of a partial eclipse by digits, a term still found in the almanacs. Dividing the surface of the sun or moon into twelfths, the body was said to be obscured by so many twelfths, or digits.

FREQUENCY OF ECLIPSES. Solar eclipses occur more frequently than do the lunar; it is unnecessary to state that there must be at least two solar eclipses annually, and there may be five, in one year. Of lunar eclipses, there may be as many as three in one year, or none at all. But a lunar eclipse is visible to a whole hemisphere, and a solar eclipse can be seen only from a small portion of the earth. The number of times, therefore, a solar eclipse can be viewed in any one place in, say, any one century, is comparatively small. The shadow at some eclipses may fall entirely in Arctic or inaccessible regions. Hence arises the infrequency, apparent, not real, of solar eclipses.

It will assist to a conception of the importance of total solar eclipses to state that the total phase cannot possibly last longer than eight minutes. The longest duration of recent date was that of the eclipse of 1895, Aug. 29, which lasted for six minutes, 56 seconds, and which was seen by the central line. As we leave the center the time grows less, during which the totality lasts, until at the edge of the zone the duration is but a minute. This latter eclipse, with its comparatively long duration, will not recur until 1904. Into the few moments of totality the astronomer is forced to crowd all his investigations.

THE PHENOMENA OF SOLAR ECLIPSES. As soon as the last thin crescent of the sun has disappeared and the moon has entirely covered its disk, an imposing spectacle is presented. There is, first, the corona surrounding the eclipsed sun, seeming, as has been aptly said, to crown all his investigations.

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is being obscured, and during totality. In addition to the spectroscopic and photometric research, a photography is made to play an important part in during all phenomena, both in connection with the photometer and spectroscopic, and by itself. As many photographic instruments can be properly manipulated during totality, the time is well spent in making a photographic plate exposed during the whole total phase; by this means the corona may be photographed far away from the limb of the sun. At another, perhaps, the whole interval is divided into periods varying from 1 to 30 seconds, in each of which a sensitive plate is exposed. Still another photographic instrument, with a lens embracing a very wide angle, may be usefully employed to photograph the whole region of the sky roundabout the sun, the farther the better. Photographs of the partial phases even are useful, as, with appropriate means, they are to be relied on for better positions of the sun and moon than are obtained by direct measurement, especially

in like manner we find that the eclipse in New York city begins at sunset, and that it is invisible to the inhabitants of New England and northeastern New York. The sun will be eclipsed at all points embraced in the right-hand loop, and rise eclipsed at all places within the left-hand loop.

OBSERVING PARTIES. As far as my information extends, the expeditions enumerated below will take up their stations on or near the central line. In choosing a station a number of conditions are sought to be fulfilled, and failing to realize them all, the most desirable are combined as far as possible. A few of these may be indicated. A station should be situated near the central line to get the full benefit of every second of totality, and as near the west of the belt as possible, for the same purpose, the duration gradually decreasing eastward; the station, especially for spectroscopic and other nice observations, should be an elevated one, where the rarer atmosphere will less interfere; meteorological conditions must be considered. Near the coast of California fogs or rain are liable to be encountered; likewise on the coast-range; east of this, however, perhaps in the valley, perhaps on the higher land still farther east, stations will be fixed. The station, finally, should be easily accessible, although astronomers do not shrink from such obstacles as inconvenience and fatigue; the enemies they fear are the weather and the atmosphere.

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At Nelson, Cal., the well-known observer, Dr. Lewis Swift, of the Warner Observatory, Rochester, N. Y., will be stationed.

Mr. Chas. Bueckhalter, of Chabot Observatory, Oakland, Cal., will lead a party, it is said, of 20 amateur photographers to some station in California.

A distinguished party will assemble at Winnemucca, Nev., consisting of a number of scientists from Harvard College Observatory, headed by Prof. W. H. Pickering, who observed the eclipse of 1886 in the island of Grenada, West Indies; Mr. John A. Brashear, the competent telescope and instrument maker of Allegheny, Pa., and the Messrs. Davidson, sons of Prof. Davidson of the Coast Survey.

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Many private observers throughout the country will observe at least the partial phases. Besides, some astronomers will go on to California and Nevada only to see the phenomenon at a convenient place, among others, Dr. W. T. Elkin, Director of the Yale College Observatory.

Not more the thousands of observers who have a greater or less interest in things astronomical, will be seen on the coast of California. States will swell the number of those gazing on nature's grand inauguration of the new year.

Congress not having made an appropriation for fitting out the expedition, the work of the Naval Observatory must be limited to watching the small partial phase to sunset.

It will be readily gathered from what has preceded that in a century we can possibly have but one such eclipse, and that for a station the phenomena revealed by solar eclipses. The astronomer, leaving home to utilize the results of years of study and preparation, may after a long journey find the weather or at best will have only a few moments of time for his scrutiny of the sun and of its surroundings. Yet such is the good-natured rivalry that exists among scientists, that even these meager opportunities are eagerly embraced, and the National Governments have time and again vied with each other in providing means for the equipment of expeditions to distant stations, where private resources would have failed.

Line of totality in a solar eclipse is a place of meeting where nationalities are waited and where astronomers of many climes gather to contribute each his share to discovery and research in a branch of astronomy, where as yet "more mysteries have been revealed than explained."

Last of the "Old Defenders." James Chamberlain Morford, aged 94 years, the last of the Old Defenders of Baltimore, died in Baltimore, Md., last week, and the association is now extinct. The organization, composed of those who defended the city at North Point against the British in the war of 1812, was formed in 1842 with 1,250 members, the majority of whom lived in Baltimore. It was the custom of the members to attend church in a body the Sunday previous to every 12th of September, each member wearing a cockade and a piece of crepe, the latter out of respect to the memory of dead comrades. On the glorious 12th they would assemble at the City Hall, march twice around the Battle Monument, and go to some convenient place out of town to eat their annual dinner. Fifteen years ago about 100 attended the Reunion, and in 1884 there were but seven. Only four of those who were present at the Reunion, and the association dissolved.

As Unlucky Wrong. Conrad E. R. Duffy, M. D., of Hancock Post, N. Y., still endeavoring to have the wrong done him in his removal from the Customs Service corrected. It will be remembered by many that Conrad Duffy, while on duty, struck a fellow officer who had made an insulting remark about the Star of Charity which he had gone on board the steamship of which they were in charge. Both officers were removed by the Collector Hancock Duffy not being satisfied with the explanation given by the Secretary of the Treasury, and finally to the President, and some months ago the latter promised he should be reinstated. Nothing has been done, however, and the wrong done to Duffy is a lasting one. He appealed to the War, was in 37 engagements, was wounded seven times, lost a leg, and made a first-class record in every respect. He was the first doctor at Hancock's side after his severe wound at Gettysburg, and it was his prompt attention that in all probability saved the hero's life.

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Palmer's Mistake. [Philadelphia Times (Dem.)] There is widespread opinion among politicians here that Gen. Palmer, of Illinois, made a fatal mistake politically in so summarily withdrawing from the Grand Army of the Republic. He was looked upon as the coming man to lead Democrats in their next presidential contest. His course is, it is conceded, will be likely to make even a Democratic convention, as far as Northern sentiment is a factor, very slow about taking him as a National candidate. The Democrats from the West, however, are numerous as was expected, and the General's Illinois friends say that he was a little too hasty.

Duration, 2m.; therefore, beginning of total phase, 9h. 44m; end of total phase, 9h. 46m. This time is Greenwich time. With our convenient divisions of time, it is easy to get the local time standard time, and just a few hours slow of Greenwich. Therefore, we have

FOR POINT ARENA, CAL.

Beginning of totality, 9h. 45m. Middle of totality, 9h. 45m. End of totality, 9h. 46m.

In a similar manner the times and phases may be found for any point of the country, remembering only to convert the Greenwich time taken from the standard time by subtracting five, six, seven or eight hours, as the place may happen to use Eastern, Central, Mountain or Pacific standard time.

Take as a further example Detroit, Mich. Beginning of totality, 9h. 30m. Middle of totality, 9h. 30m. End of totality, 9h. 31m.

Being between the full lines "Eclipse begins at sunset" and "Middle of eclipse is visible," the sun will set eclipsed; and, being removed from the latter line toward the former, the phase will be less than six digits (one-half), or about five digits.

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In a similar manner the times and phases may be found for any point of the country, remembering only to convert the Greenwich time taken from the standard time by subtracting five, six, seven or eight hours, as the place may happen to use Eastern, Central, Mountain or Pacific standard time.

Take as a further example Detroit, Mich. Beginning of totality, 9h. 30m. Middle of totality, 9h. 30m. End of totality, 9h. 31m.

Being between the full lines "Eclipse begins at sunset" and "Middle of eclipse is visible," the sun will set eclipsed; and, being removed from the latter line toward the former, the phase will be less than six digits (one-half), or about five digits.

As far as my information extends, the expeditions enumerated below will take up their stations on or near the central line. In choosing a station a number of conditions are sought to be fulfilled, and failing to realize them all, the most desirable are combined as far as possible. A few of these may be indicated. A station should be situated near the central line to get the full benefit of every second of totality, and as near the west of the belt as possible, for the same purpose, the duration gradually decreasing eastward; the station, especially for spectroscopic and other nice observations, should be an elevated one, where the rarer atmosphere will less interfere; meteorological conditions must be considered. Near the coast of California fogs or rain are liable to be encountered; likewise on the coast-range; east of this, however, perhaps in the valley, perhaps on the higher land still farther east, stations will be fixed. The station, finally, should be easily accessible, although astronomers do not shrink from such obstacles as inconvenience and fatigue; the enemies they fear are the weather and the atmosphere.

The total solar eclipse may be said to be to the astronomer what the line is to the sailor. Many young scientists will, we trust, receive their initiation Jan. 1, 1889. Unfortunately to the sun, which is the south of the zone of totality, otherwise its nice equipment could be most advantageously utilized. But it is reported that expeditions will be sent into the interior of the continent.

Mr. Chas. H. Rockwell, of Tarrytown, N. Y., a member of the eclipse expedition to the Caroline Islands in 1883, will observe at some point in California.

At Nelson, Cal., the well-known observer, Dr. Lewis Swift, of the Warner Observatory, Rochester, N. Y., will be stationed.

Mr. Chas. Bueckhalter, of Chabot Observatory, Oakland, Cal., will lead a party, it is said, of 20 amateur photographers to some station in California.

A distinguished party will assemble at Winnemucca, Nev., consisting of a number of scientists from Harvard College Observatory, headed by Prof. W. H. Pickering, who observed the eclipse of 1886 in the island of Grenada, West Indies; Mr. John A. Brashear, the competent telescope and instrument maker of Allegheny, Pa., and the Messrs. Davidson, sons of Prof. Davidson of the Coast Survey.

Prof. Pritchett, of the Glasgow (Mo.)